

REMARKS

Reconsideration of the above-identified patent application in view of the present amendment and the following remarks is respectfully requested.

Attached is a substitute specification, including a clean copy and a copy showing the changes made. The substitute specification includes no new matter. The changes to the specification include adding suffixes to the reference numbers so as to correspond to the reference numbers shown in a proposed drawing amendment that is being filed contemporaneously with the present amendment. The suffixes have been added to the reference numbers to overcome the objection that the drawings use the same reference numbers in different figures.

Additionally, the specification has been amended to overcome the objection that the specification failed to provide antecedent basis for the exact terminology of claim 17. A summary of claim 17 has been added to the specification. This summary includes the exact terminology of claim 17. Moreover, page 4 of the specification has been amended to remove informalities. Again, no new matter has been added to the specification. The amendments to the specification overcome the objections to the specification.

As stated above, a proposed drawing amendment is being filed contemporaneously with the present amendment. The proposed drawing amendment consists of adding the suffix "a" to the reference numbers of Fig. 1, adding the suffix "b" to

the reference numbers of Fig. 2, and adding the suffix "c" to the reference numbers of Fig. 3. Additionally, Fig. 4, which originally showed two embodiments of the invention, has been divided into Fig. 4a and Fig. 4b. The suffix "d" has been added to the reference numbers in Fig. 4b. Reference number 25 with the appropriate suffix has been added to the drawings to indicate the gap. The proposed drawing amendment overcomes the objection to the drawings.

This amendment also adds new claim 29, cancels claim 26, and amends claim 27. Claim 29 is claim 26, which was indicated as allowable, rewritten in independent form. Claim 27, which was indicated as allowable, has been amended to depend from claim 29.

Anticipation requires a single prior art reference that discloses each element of the claim. W.L. Gore & Associates v. Garlock, Inc., 220 UPSQ 303, 313 (Fed. Cir. 1983) cert. denied 469 U.S. 851 (1984). For a reference to anticipate a claim, "[t]here must be no difference between the claimed invention and the reference disclosure, as viewed by a person of ordinary skill in the field of the invention." Scripps Clinic & Research Foundation v. Genentech Inc., 18 USPQ2d 1001, 1010 (Fed. Cir. 1991).

Claim 17 was rejected as anticipated under 35 U.S.C. §102(b) by Flumerfelt, U.S. Patent No. 2,181,300. This rejection is respectfully traversed.

Claim 17 recites structure interposed between the housing cover and at least a portion of the bearing shell and acting

upon the portion of the bearing shell to urge the portion of the bearing shell toward the first axial end of the joint housing and, in response to wear of the portion of the bearing shell, to wedge the portion of the bearing shell into a gap between the ball head and the joint housing adjacent the ball stud at the first axial end of the joint housing. Flumerfelt fails to teach or suggest this feature of claim 17.

Specifically, Flumerfelt fails to teach or suggest structure that, in response to wear of the portion of the bearing shell, wedges the portion of the bearing shell into the gap. In rejecting claim 17, the Examiner makes the following statement with regard to Flumerfelt, "[t]he structure 30 is for urging the portion A10 toward the first axial end A2 of the joint housing 10, in response to wear of the portion A10 of the bearing shell 22 and for wedging the portion of the bearing shell 22 into the gap A6." It is respectfully submitted that this statement incorrectly describes the device shown and described in Flumerfelt.

Reference 30 in Flumerfelt is a spring washer that acts between fixed bearing seat 22 and movable bearing seat 23. (Page 1, col. 2, lines 20-25). The movable bearing seat 23 is slidable in the housing and the spring washer 30 tends to urge the bearing seat 23 into contact with the equatorial region of the ball portion 25 of the ball stud. (Page 1, col. 2, lines 44-46). "[T]he spring washer 30 exerts a downward pressure upon the bearing seat 23 so that the latter is caused to wedgingly engage the ball stud at the most effective area of

the ball stud to take up wear...." (See, Page 1, col. 2, line 53-page 2, col. 1, line 2). Bearing seat 22 is fixed relative to the housing 10 and is in abutting engagement with shoulder 15 of the housing 10. (Page 1, col. 2, lines 6-17, and page 2, col. 1, lines 9-14). Thus, according to the teachings of Flumerfelt, bearing seat 22 is fixed relative to the housing and bearing seat 23 engages the equatorial region of the ball portion 25 for taking up wear.

A word in a claim must be given its plain meaning unless specifically defined in the specification of the patent application. M.P.E.P. §2111.01. The plain meaning of a term is the meaning given to that term by those of ordinary skill in the art. M.P.E.P. §2111.01. Therefore, the plain meaning of the verb "wedge" to those skilled in the art must be considered when examining claim 17. Webster's II, New College Dictionary (1999) defines "wedge" as "to crowd, push, or force into a limited space." It is respectfully suggested that one of ordinary skill in the art would interpret the verb "wedge" as defined above.

The spring 30 of Flumerfelt urges bearing seat 22 against the shoulder 15 of the housing 10, in a direction away from the head portion 25 of the ball stud. Thus, the spring 30 fails to wedge the bearing seat 22 into a gap between the head portion 25 and the housing 10 in response to wear of the bearing seat 22,. Thus, Flumerfelt fails to teach or suggest each feature of claim 17 and allowance of claim 17 is respectfully requested.

Furthermore, with respect to Flumerfelt, as the portion that the Examiner refers to as A10 on the bearing shell 22 wears, the spring 32 moves the ball stud 26 upwardly, as shown in Fig. 1, toward shoulder 15. The structure of claim 17 prevents movement of the ball stud relative to the joint housing. In response to wear of the bearing shell, the structure of claim 17 wedges the bearing shell into the gap between the ball head and the joint housing and, as a result, prevents movement of the ball stud relative to the joint housing. Thus, for this further reason, Flumerfelt fails to disclose the structure of claim 17 and allowance of claim 17 is respectfully requested.

Moreover, Flumerfelt teaches away from the invention of claim 17. "A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant..." See, In re Gurley, 31 USPQ2d 1130, 1131 (Fed. Cir. 1994). Flumerfelt teaches wedging bearing seat 23 between the head portion 25 of the ball stud and the housing at the equatorial region of the ball stud. (Page 1, col. 2, lines 47-53). Flumerfelt further teaches that the most effective area of the ball stud to engage for compensating for wear is the equatorial region of the ball stud. (Page 1, col. 2, line 53 to page 2, col. 1, line 2). Thus, one of ordinary skill in the art of ball joints, when attempting to compensate for wear and given the teachings of

Flumerfelt, will be led by Flumerfelt to wedge a bearing seat between the ball stud and the housing at the equatorial region of the ball stud. Thus, Flumerfelt teaches away from, or in a direction divergent from, the structure of claim 17. Therefore, for this additional reason, allowance of claim 17 is respectfully requested.

Claims 18, 22-25, and 38 depend from claim 17. Claims 18, 22-25, and 38 are allowable over Flumerfelt for at least the same reasons as claim 17.

Claim 17 was also rejected under 35 U.S.C. §102(e) as anticipated by Littman, U.S. Patent No. 6,010,272. This rejection of claim 17 is also respectfully traversed.

Littman also fails to teach or suggest structure interposed between the housing cover and at least a portion of the bearing shell and acting upon the portion of the bearing shell to urge the portion of the bearing shell toward the first axial end of the joint housing and, in response to wear of the portion of the bearing shell, to wedge the portion of the bearing shell into a gap between the ball head and the joint housing adjacent the ball stud at the first axial end of the joint housing. In rejecting claim 17, the Examiner marked the gap on a copy of Fig. 4 of Littman attached to the Office Action with reference number A6. Reference number A6 is located in the center of the socket 60b near the pivot center 118b of the ball joint. Claim 17 recites that the gap is between the ball head and the joint housing adjacent the ball stud at the first axial end of the joint housing. Littman

fails to teach a portion of bearing element 130b being wedged into a gap between the ball head and the joint housing adjacent the ball stud at the first axial end of the joint housing. In fact, Fig. 4 of Littman illustrates an area of the socket 60b adjacent the shank 80b at the end of the socket, indicated by rim 74b, as being an open or unoccupied space. Since Littman fails to teach or suggest each feature of claim 17, the rejections of claim 17 as anticipated by Littman is improper and should be withdrawn. Therefore, allowance of claim 17 is respectfully requested.

Claims 18, 22-25, and 38 depend from claim 17 and are allowable over Littman for at least the same reasons as claim 17.

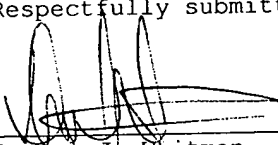
In view of the foregoing, it is respectfully submitted that the above-identified patent application is in condition for allowance, and allowance of the above-identified patent application is respectfully requested.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned "Version with markings to show changes made."

Serial No. 09/640,038

Please charge any deficiency or credit any overpayment in  
the fees for this amendment to our Deposit Account  
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Respectfully submitted,

  
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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

A substitute specification, including a marked-up copy and a clean copy, is attached.

IN THE CLAIMS:

Claim 26, which was indicated as allowable, has been rewritten as new claim 29.

Claim 26 was cancelled.

Claim 27 has been amended as follows:

27. (Amended) The ball-and-socket joint as claimed in claim ~~26~~ 29 wherein the collar includes deformable areas, the deformable areas of the collar enabling a combination of the upper shell, the spring element, and the lower shell to be adapted for use with joint housings of varying tolerances.



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Ball-and-Socket Joint with Bearing Shell

5 The present invention relates to a ball-and-socket joint comprising a joint housing, a ball head with ball pivot, a bearing shell arranged between ball head and joint housing, and a housing cover.

BACKGROUND OF THE INVENTION

10 Ball-and-socket joints of said type are known in the art and are preferably used in motor vehicles. The ball head of the ball-and-socket joint is rotatably and tiltably supported in the bearing shell, and the bearing shell in turn is arranged in the joint housing.

15 The purpose of the bearing shell, which is usually exposed to hard wear, is to compensate the lateral forces acting on the ball-and-socket joint and to absorb shocks to the joint housing and to the ball pivot. The bearing shell is therefore advantageously made of an elastic plastic that can be elastically deformed as a result of the forces acting on the ball-and-socket joint.

20 To ensure that the ball head is not enclosed too tightly by the bearing shell during assembly of a ball-and-socket joint of the initially mentioned type and that the joint is not too stiff, tight manufacturing tolerances are required particularly in the production of the joint housing. To compensate stiffness of the ball-and-socket

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joint due to imprecise manufacturing tolerances, a bearing shell has been proposed, which at one end face is provided with very small projections whose height slightly exceeds the manufacturing tolerances of the joint. These projections are deformed when correspondingly high forces are applied as the joint is assembled and have the purpose of compensating the manufacturing tolerances of the joint members such that the tolerance for free movement of the ball-and-socket joints can be kept within limits. However, wear of the bearing shell cannot be compensated by these projections.

With increasing wear of the bearing shell, an undesirable, continuously increasing bearing clearance develops between ball head and bearing shell. With respect to the operating life of the ball-and-socket joint this causes a change in the motive torques of the bearing journal as well as a continuous change in the elasticity properties of the bearing shell. As a consequence, the bearing is no longer exact, which results in imprecise wheel guidance of the ball-and-socket joint and noise development.

Thus, based on this prior art, the object of the present invention is to further develop a ball-and-socket joint of the initially mentioned type to reduce the tolerance of free movement and increase the life of the ball-and-socket joint while simultaneously simplifying the assembly.

## 20 SUMMARY OF THE INVENTION

To attain this object, it is proposed according to the invention that a compressive force, which is produced between the housing cover and at least a portion of the bearing shell and axially acts in the direction of the ball pivot, permanently acts on this portion of the bearing shell and presses it into the gap between ball head and joint housing.

The ball and socket joint comprises a joint housing having first and second axial ends. A ball head with a ball stud extending from the ball head is received in the joint housing. The ball stud extends outward of the first axial end of the joint

housing. A gap is formed between the ball head and the joint housing adjacent the ball stud at the first axial end of the joint housing. A bearing shell is received in the joint housing for supporting the ball head for tilting relative to the joint housing. The second axial end of the joint housing is closed by a housing cover. 5 Structure is interposed between the housing cover and at least a portion of the bearing shell. The structure acts upon the portion of the bearing shell to urge the portion of the bearing shell toward the first axial end of the joint housing and, in response to wear of the portion of the bearing shell, to wedge the portion of the bearing shell into the gap. Due to this wedging, the ball head is kept in its correct 10 position within the joint housing preventing a change of position of the ball stud.

This ball-and-socket joint designed according to this technical teaching advantageously allows the compensation of inaccuracies that are due to manufacturing tolerances of the joint members as well to wear. Unlike in prior art processes, the ball-and-socket joint according to the invention is assembled with 15 an intentional axial clearance of the bearing shell in relation to the rolled-in housing cover with respect to both maximum and minimum manufacturing tolerances. The compressive force, which on the cover-side permanently acts in axial direction of the ball pivot on at least a portion of the bearing shell, presses this portion of the bearing shell into the gap between ball head and ball-and- 20 socket joint such that, independent of the different manufacturing tolerances of the individual ball-and-socket joint components, the ball head is supported in the bearing shell under the action of axial forces that are always the same so that different freedoms of movement of the ball joints are avoided. The compressive force can be applied to the bearing shell either directly below the housing cover or it can act on any intersection line or plane as a part of the bearing shell. Due to 25 tolerance compensation, the motive torques of the ball-and-socket joint and the elastic properties of the bearing shell are thus largely independent of the manufacturing process and the resultant manufacturing tolerances of the joint members. Furthermore, the tilting torque of the ball-and-socket joint and the 30 elasticities of the bearing shell can be adjusted in an advantageous manner by correspondingly selecting the compressive force acting on the bearing shell after

assembly of the ball-and-socket joint. This makes it possible to produce ball-and-socket joints with low motive torques and elasticities while keeping dimensional tolerances acceptable in terms of process engineering with less variation of the joint properties.

- 5 The ball-and-socket joint according to the invention also advantageously compensates wear of the bearing shell. The compressive force permanently acting on the bearing shell causes the bearing shell to advance continuously as wear occurs, such that, in terms of a "self adjustment" of the bearing shell, the ball head is always supported in the bearing shell under the action of identical  
10 axial-elastic wedge effects. This ensures largely constant motive torques of the ball-and-socket joint on the one hand and essentially unchanging elastic properties of the bearing shell on the other hand, which advantageously increases the life of the ball-and-socket joint.

- To produce the compressive force permanently acting on the bearing shell, the  
15 present invention proposes plastically to deform the housing cover in axial direction of the ball pivot with a specifically definable force. A disk made of an elastic material and disposed between housing cover and bearing shell is elastically deformed by the plastic deformation of the housing cover. This generates a preloading force that is applied to the bearing shell as a permanently  
20 acting compressive force. Thus, a defined pressing in of the housing cover makes it possible to achieve an exactly definable preloading force of the ball-and-socket joint. According to a particular advantage of the invention, both the housing cover and the disk have an outwardly facing trapezoidal curvature. The inside [...] and of the housing cover [sic] rests against and fully contacts the disk  
25 in the area of the trapezoidal curvature based on a defined applied force and a deformation of the housing cover. This effect can furthermore be enhanced in that the torque of the ball pivot is measured or monitored as the housing cover is pressed in, and the measured data is used to control the pressing-in force.

- According to an alternative embodiment, the compressive force permanently  
30 acting on the bearing shell is produced by means of a spring that is arranged

between the housing cover and the bearing shell and supported against the joint housing via the housing cover. With particular advantage, it is proposed that the spring is a trapezoidal disk spring with an outward curvature. When the joint housing is closed with a rigid housing cover, the disk spring disposed between bearing shell and housing cover is compressed and the resultant spring force permanently acts on the bearing shell in axial direction of the pivot pin in the form of a compressive force. By selecting a corresponding disk spring and its initial stress, the disk spring force and thus also the preloading force of the ball-and-socket joint can be adjusted. According to a further advantageous proposal of the invention, an additional load transmission disk may be disposed between disk spring and bearing shell to optimize introduction of the force into the bearing shell. In a further advantageous embodiment, the contact area between spring and disk is designed as a deformable area. During assembly, after flattening of the spring, this area is deformed to a sufficient degree until the bearing shell has reached its axial end position. The initial preloading of the joint is thus independent of the tolerances of the individual components and the size of the spring force.

According to an alternative embodiment, the bearing shell arranged between ball head and joint housing has a two-part design and is divided into an upper shell and a lower shell. This partitioning of the bearing shell into two parts advantageously creates two mutually independent functional areas that may be designed according to the requirements they are intended to meet. For example, the upper shell serves to compensate the inaccuracies due to the manufacturing tolerances of the joint members, whereas the lower shell compensates wear.

To compensate the inaccuracies due to the manufacturing tolerances in the assembly of the ball joint, the invention proposes that the upper shell, on the housing cover side, be provided with a collar, which in the assembled state of the ball-and-socket joint is wedged between the housing cover and a housing shoulder. To assemble the ball-and-socket joint, a compressive force acting in axial direction of the ball pivot is generated on the cover side and applied via the housing cover to press the bearing shells into the gap between ball head and

- housing. The compressive force acting during assembly is transmitted from the upper shell to the lower shell. The inaccuracies due to the manufacturing tolerances of the joint members can be compensated due to a plastic deformation of the collar arranged between the actual upper shell and the housing cover. The axial end position of the upper and lower shell is established as a function of the tolerances of the individual components, such that, irrespective of manufacturing tolerances, the ball head is supported in the bearing shell and different freedoms of movement of the ball-and-socket joints are avoided.
- According to a further feature of the invention, to compensate wear of the bearing shell, a spring element is disposed in axial direction between upper shell and lower shell. In the assembled state, this spring element is supported against the housing cover via the upper shell and produces a compressive force permanently acting on the lower shell, which causes a continuous advancement of the lower shell as wear occurs. This allows a "self-adjustment" of the lower shell of the ball head under the action of axial-elastic wedge effects that remain always the same and achieves, on the one hand, motive torques that are largely constant and on the other hand essentially unchanged elastic properties of the bearing shell. This advantageously prolongs the life of the ball-and-socket joint. According to a further feature of the invention, the spring element disposed between upper shell and lower shell is a spring washer of a wave-shaped design that is pushed up completely after assembly and thus can transmit the full magnitude of the assembly compressive force to the lower shell.
- Insertion of the bearing shell into the joint housing can be carried out in separate consecutive steps, or the individual components, lower shell, spring element and upper shell, can be combined into a packet and inserted into the joint housing as a unit in a single assembly step. To form the assembly packet, the upper and lower shell can be fabricated in a common injection mold with a corresponding recess being provided to receive the spring element that separates the lower shell from the upper shell. Irrespective of whether the bearing shell is assembled in a single step or in multiple steps, it has proven to be advantageous to give the

lower shell a cylindrical contour prior to its assembly and in contrast to its embodiment after completed assembly.

## BRIEF DESCRIPTION OF THE INVENTION

Further details and advantages of the invention will become clear from the following description by means of the drawings in which

Fig. 1 is a sectional view of a ball-and-socket joint with an integrally formed housing cover,

Fig. 2 is a sectional view of a ball-and-socket joint with a disk spring disposed between bearing shell and housing cover according to a first embodiment,

Fig. 3 is a sectional view of a ball-and-socket joint with a disk spring disposed between bearing shell and housing cover according to a second embodiment,

Fig. 4a is a sectional view of a ball-and-socket joint with a two-part bearing shell and a spring washer,

Fig. 4b is a sectional view of a further ball-and-socket joint with a two-part bearing shell and a spring washer, and

Fig. 5 is a three-dimensional view of the spring washer ~~according to Fig. 4~~for use in the ball-and-socket joint of Figs. 4a.

## 20 DETAILED DESCRIPTION OF THE INVENTION

The ball-and-socket joint depicted in Fig. 1 essentially comprises a ball head 2 2a with integrally formed ball pivot 3 3a and a joint housing 4 1a sealed with a housing cover 5 5a. The ball head 2 2a is supported in a bearing shell 4 4a, which in turn is arranged in joint housing 4 1a. The bearing shell 4 4a is designed



as one piece, contacts the ball head 2 2a with its sliding surface 7 7a on both sides of the equatorial plane 8 8a and supports it.

As the ball-and-socket joint is assembled, a precisely defined force  $F_v$  is applied to the housing cover 5 5a provided with an outwardly facing trapezoidal curvature, which causes a plastic deformation of the housing cover 5 5a in the area of the trapezoidal curvature. In this figure, force  $F_v$  is indicated by a dashed line. Based on this plastic deformation of the housing cover 5 5a, the disk 6 6a disposed between bearing shell 4 4a and housing cover 5 5a is elastically deformed and applies a permanent compressive force to the bearing shell 4 4a in axial direction of the ball pivot 3 3a. This causes bearing shell 4 4a to be pressed into the gap 25a between joint housing 4 1a and ball head 2 2a. This has the advantage that the ball-and-socket joint is not susceptible to manufacturing tolerances of the joint members, particularly of joint housing 4 1a and ball head 2 2a, and that the preloading force of the ball-and-socket joint can be adjusted by means of the precisely defined pressing-in force  $F_v$ . The motive torques of the ball-and-socket joint, which are determined by the preloading force as well as the elastic properties of the bearing shell 4 4a can thus also be specifically adjusted via the pressing-in force  $F_v$  irrespective of the manufacturing tolerances. This makes it possible to produce a ball-and-socket joint with low motive torques and elasticities, which despite acceptable dimensional tolerances in terms of process engineering has a narrow variation range with respect to the motive torques and the elasticities. As wear occurs in the bearing shell 4 4a, the compressive force permanently acting on the bearing shell causes the bearing shell 4 4a to advance into the gap 25a between ball head 2 2a and joint housing 4 1a. This “self-adjustment” of the bearing shell 4 4a ensures nearly identical motive torques and elasticity properties despite wear. Prior to assembly, the bearing shell preferably has a cylindrical contour 23 23a on the pivot side, which only after assembly is plastically deformed into its final ball-shaped contour.

In the embodiment of the ball-and-socket joint according to the invention shown in Fig. 2, the compressive force permanently acting on the bearing shell 4 4b in axial direction of the ball pivot 3 3b is produced by means of a disk spring 9 9b

disposed between bearing shell 4 4b and housing cover 5 5b. For better force application to the bearing shell 4 4b, a load transmission disk 6 6b is arranged between disk spring 9 9b and bearing shell 4 4b. The desired preloading force of the ball-and-socket joint can be adjusted through a corresponding selection of the disk spring properties. As described above, the compressive force generated by the disk spring 9 9b and transmitted to the bearing shell 4 4b also serves to press the bearing shell 4 4b into the gap 25b between the ball head 2 2b and joint housing 4 1b. Consequently, the ball-and-socket joint is not susceptible to manufacturing tolerances on the one hand, and the wear contour 40 10b is compensated by an axial advance of the bearing shell on the other hand. The embodiment of the joint housing 4 1b shown in Fig. 2 has a substantially cylindrical inner contour starting from the equatorial plane 8 8b of the ball head 2 2b toward the cover-side end. This inner contour, according to a special embodiment of joint housing 4 1b, can be conical with a tapering diameter in the direction of the equatorial plane 8 8b of the ball head 2 2b. This is indicated by the dashed line 44 11b. If a joint housing 4 1b with conical inner contour is used, the bearing shell 4 4b is correspondingly adapted. The conical embodiment of the inner contour advantageously reduces the torque of the ball-and-socket joint caused by the permanently acting compressive force of the spring 9 9b. According to a further embodiment of the ball-and-socket joint, an elastic ring made of rubber is disposed between bearing shell 4 4b and housing cover 5 5b instead of the disk spring 9 9b.

In a further preferred embodiment, the contact area between spring 9 9b or disk 6 6b is made as a deformable area 24 24b. During assembly, this area, after flattening of the spring, is deformed to a sufficient degree until the bearing shell 4 4b has reached its axial end position. The initial preloading of the joint is thus independent of the tolerances of the individual components and the size of the spring force.

Fig. 3, according to a second embodiment, also shows a ball-and-socket joint with a spring disk 9 9c disposed between bearing shell 4 4c and housing cover 5 5c. In contrast to the embodiment depicted in Fig. 2, a circumferential collar 47

17c is provided instead of a load transmission disk disposed between disk spring 9 9c and bearing shell 4 4c. In the assembled state of the ball-and-socket joint this collar 47 17c rests against the disk spring 9 9c and transmits the compressive force generated by the disk spring 9 9c to the bearing shell. The circumferential collar 47 17c and the bearing shell 4c are designed as one piece, but in contrast to the embodiment shown in Fig. 2, the bearing shell is formed as a closed bearing shell 42 12c. The collar 47 17c is provided with a shoulder 48 18c and with snap locking means 49 19c for a secure seat of the disk spring 9 9c. As explained above in connection with the embodiment according to Fig. 2, the desired preloading force of the ball-and-socket joint can be adjusted via a corresponding selection of the disk spring properties in this embodiment as well.

Fig. 4 4a shows an ~~embodiment of the~~ a left part of a ball-and-socket joint according to the invention ~~whereas Fig. 4b shows a right part of a further ball-and-socket joint according to the invention.~~ The embodiments of Figs. 4a and 4b both have ~~with~~ a two-part design of the bearing shell comprising an upper and a lower shell 43, 44, ~~and 15.~~ The upper and lower shells are labeled 15 and 13, respectively, in Fig. 4a and are labeled 14d and 13d, respectively, in Fig. 4b. The embodiment depicted ~~on the left of the drawing in Fig. 4a~~ shows an upper shell 15 with an open design and the embodiment depicted ~~on the right half of the figure in Fig. 4b~~ shows an upper shell 44 14d with a closed design. The upper shell 44, 15, 14d has an integrally formed circumferential collar 17, 17d on the cover side, which in the assembled state of the ball-and-socket joint is wedged between the housing cover 5, 5d and the housing shoulder 20, 20d. This circumferential collar 17, 17d has deformable areas 21 and 22, 21d and 22d that have a tolerance compensating effect on the axial position of the upper and lower shell 44, 15, 16 15, 14d and 13, 13d when the joint is assembled. To compensate wear of the bearing shell, a spring element in the form of a wave-shaped washer 16, 16d is provided between the upper shell 44, 15, 14d, and the lower shell 13, 13d. This spring washer 16, 16d is supported against the housing cover 5, 5d via the upper shell 44, 15, 14d and applies a compressive force permanently acting on the lower shell 13, 13d, which causes the lower shell 13, 13d continuously to

advance as wear occurs. This "self adjustment" of the lower shell 13, 13d makes it possible that the ball head 2, 2d is supported in the bearing shell 42 under the action of axial-elastic wedge effects that remain always the same. During assembly, this spring washer is flattened and the full magnitude of the assembly  
 5 compressive force is thereby transmitted from the upper to the lower shell.

In contrast to the embodiments depicted in Fig. 1 to 3, the two-part embodiment of bearing shell 42 has the effect of a functional division. The upper shell 44, 15, 14d with its integrally formed rim 17, 17d serves to compensate inaccuracies due to manufacturing tolerances, whereas the lower shell 13, 13d compensates wear.  
 10 With this function-related division between upper and lower shell 43, ~~44~~, 15, 14d and 13, 13d, and the arrangement of a spring washer 16, 16d between upper and lower shell 43, ~~44~~, 15, 14d and 13, 13d, the spring force required for the advancement of the shell is advantageously reduced substantially so that low motive torques can be realized.

Fig. 5 is a three-dimensional representation of the wave-shaped spring washer 16 between upper and lower shell 43, ~~44~~, ~~15~~ 15, 13 in Fig. 4a in its non-stressed state. The spring washer 16d of Fig. 4b is similar to the wave spring 16 of Fig. 4a. Under the action of the pressing-in force that is applied to the bearing shell during assembly, ring 16 is compressed and thereafter tries to expand in axial  
 20 direction to assume the non-stressed state depicted in Fig. 5. Due to this expansion tendency of the spring washer 16, the lower shell 13 in Fig. 4a is pressed into the gap 25 between ball head 2 and joint housing 1, which makes it possible to compensate wear of bearing shell-42. Similarly, the lower shell 13d in Fig. 4b is pressed into the gap 25d between ball head 2d and joint housing 1d,  
 25 which makes it possible to compensate wear of bearing shell.

### List of Reference Symbols

- 1 — ball and socket joint
- 2 — ball head
- 3 — ball pivot
- 5 4 — bearing shell
- 5 — housing cover
- 6 — disk
- 7 — sliding surface
- 8 — equatorial plane
- 10 9 — spring
- 10 — wear contour
- 11 — dashed line
- 12 — closed bearing shell
- 13 — lower shell
- 15 14 — closed upper shell
- 15 — open upper shell
- 16 — spring washer
- 17 — collar
- 18 — shoulder
- 20 19 — snap locking means
- 20 — shoulder
- 21 — deformable area
- 22 — deformable area
- 23 — cylinder shaped contour
- 25 24 — deformable area